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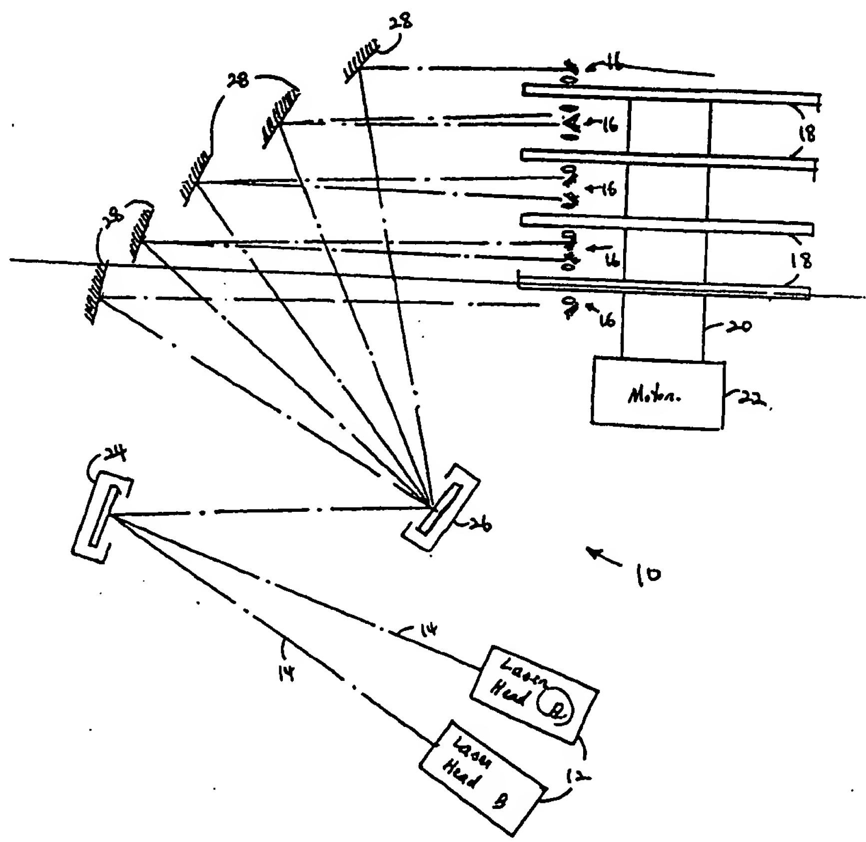
(57) Abstract

An optical disk drive (10) has a plurality of optical disks rotatably supported about an axis. The disk drive includes a switching apparatus having at least one movable mirror (24, 26) which changes its orientation to direct a light beam toward a plurality of read/write head members (16). Each head member has a head mirror (30) and a read/write objective lens (32) for directing the light beam to an optical disk.



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OPTICAL SWITCH FOR DISK DRIVE

FIELD OF THE INVENTION

The present invention generally relates to optical switching apparatus, and, in particular, to an optical switching apparatus for optical disk drive systems.

BACKGROUND OF THE INVENTION

A variety of optical disk drive systems has been proposed for use with multiple optical disks loaded on a rotationally mounted spindle, and such systems have become increasingly popular because of their large storage capabilities. A typical optical disk drive system uses one or more laser sources to transmit a laser beam onto a selected track of an optical disk. In reading applications, the beam reflected from the surface of the optical disk is monitored by a signal detector to reconstruct information stored on the recording surfaces of disks.

Some of the existing multiple disk drive systems use a single head assembly mounted on an elevator carriage, which physically moves within the drive to bring the laser beam to each reflective disk surface. Some of the existing multiple disk drive systems use a multiple head assembly system, where one head assembly is assigned to each of reflective surfaces of the optical disks. Others, such as disclosed in U.S. Pat. No. 5,153,870 to Lee et al., provide a rotary head actuator which employs an optically switchable reflector using removable index matching fluid to distribute a laser beam from a laser source to one of several optical disks.

These prior art storage devices suffer from various disadvantages. For example, one problem associated with some of the known storage devices is that additional access time is required during positioning of the laser beam between optical disks. This problem is more prevalent when the requested data is dispersed among multiple disk surfaces. Some storage devices are expensive to manufacture and cumbersome to fit into small cases since each head assembly contains a complete set of optical head components, including laser beam source, detector, mirrors and lenses.

SUMMARY OF THE INVENTION

The inventor has recognized that the operation of optical devices, such as optical disk drives, may be further enhanced by incorporating one or more movable mirrors to effectively switch a laser beam from at least one light source to one of a plurality outputs, such as read/write heads of an optical storage device.

The present invention is directed to an apparatus and corresponding method for selectively directing a light beam from at least one light source to a number of outputs. The beam-directing apparatus uses at least one movable mirror having a reflective surface which is capable of changing its orientation to direct the light beam in a selected optical path. In a preferred embodiment, the beam-directing apparatus uses two movable mirrors, where each movable mirror is capable of rotating with respect to at least one pivot axis to selectively guide the light beam to one of the outputs.

According to one aspect of the invention, the beam-directing apparatus is used with an optical disk drive for selectively coupling a beam of light from a laser module to a selected optical disk surface. In a preferred embodiment, the beam-directing apparatus uses two movable mirrors together with stationary mirrors. Each movable mirror is capable of rotating with respect to at least one pivot axis to guide the light beam to one of the stationery mirrors. According to the invention, the optical disk drive has a plurality of head members positioned near surfaces of a plurality of optical disks to optically read and/or write information from and onto the optical disks rotatably supported about a spindle. The head members preferably include at least one set of a head mirror and an R/W objective lens located between the head mirror and the respective disk for receiving the beam of light from the beam-directing apparatus and focusing the received light beam onto a selected track of the disk.

According to another aspect of the invention, one or more movable mirrors, of any suitable type, are used in the optical switching apparatus so as to enable the light beam to be rapidly and accurately guided along a precise optical path, as required by the optical disk drive. The movable mirrors may include a movable reflective surface which is adjustable about at least one pivot axis and preferably about two pivot axes. The movable mirror is associated with a control mechanism for precisely controlling the orientation of the reflective surface in one or both pivot axes. A processor may be

coupled to the control mechanisms of the movable mirrors in order to coordinate their movements to selectively switch the optical path of the laser beam between different optical read/write head members.

According to a further aspect of the invention, a plurality of stationary mirrors is provided, each associated with one of said head members. The stationary mirrors have reflective surfaces oriented at a predetermined pivotal angle to deflect the light beam from the second movable mirror to a respective head member. Although referred to herein as "stationary", such mirrors may be mounted on and move with an actuator arm, but can be stationary with respect to the mount.

The reading and writing operations are executed by first moving the read/write head associated with such optical disk to a specific target track area thereof. The laser beam emitted by the laser source is reflected by the first and second movable mirrors to one of the stationary mirrors. A processor controls the movements of the first and second movable mirrors to precisely guide the light beam to a specific spot on the selected stationary mirror, such that the beam from the stationary mirror is deflected by a head mirror and guided to the center of an R/W objective lens associated with the selected optical disk. The beam reflected from the surface of the optical disk is monitored by a signal detector to reconstruct information stored on the recording surface of the disk.

In one aspect of the invention, the optical switching apparatus includes a feedback mechanism for monitoring the position of the movable mirrors. The feedback mechanism may include an auxiliary light source for generating an auxiliary light beam and a position sensitive detector for detecting the auxiliary light beam deflected from the movable mirror in order to accurately determine the position thereof.

In another aspect of the invention, an optical disk drive is provided in which a control mechanism is used with a beam-directing apparatus for controlling the operations of the beam-directing apparatus. The beam-directing apparatus may include two movable mirrors, the orientations of which are precisely controlled by the control mechanism. The movable mirrors together with the control mechanism are capable of rapidly and accurately guiding a light beam from a selected light source to a precise optical path.

In yet another aspect of the invention, an optical disk drive is provided in which the size of the beam reflected onto an optical disk surface may be controllable by a beam-

directing apparatus. The focusing of the beam on an optical disk surface may be controlled with use of two movable mirrors, accomplished by controlling the position of the laser beam impinging upon the second movable mirror with the first movable mirror. In a related aspect of the invention, the tracking of the beam on the optical disk surface may also be controlled by controlling the position of the laser beam impinging upon the second movable mirror with the first movable mirror.

In a further aspect of the invention, a movable mirror is provided. The movable mirror includes a reflector rotatable about at least one pivot axis. The reflector is adjustably supported between a support surface and at least one actuator so as to cause the reflector to rotate about pivot axis in either direction as the actuator moves toward or away the reflector. This movable mirror may be used in the read/write head members so that the orientation of its reflector may be adjusted, as required for focusing and tracking needs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic perspective view of a preferred embodiment of an optical switching apparatus in accordance with the principles of the present invention.

FIG. 2 is an enlarged side elevational view of a read/write head located between two optical disks, illustrating mirrors positioned to reflect light beams to a respective lens through which the light beams become focused onto the respective disk.

FIG. 3 is an enlarged side elevational view of an R/W objective lens positioned with respect to the optical disk, illustrating a spherical focal plane of the R/W objective lens.

FIG. 4 is a plan view showing a portion of tracks on the disk surface in relation to focus circles representing a range of various focus conditions.

FIG. 5 is a diagrammatic perspective view of a light beam, guided by the first and second movable mirrors and reflected by a selected one of the stationary mirror and a head mirror, being directed into the R/W objective lens.

FIG. 6 is a diagram illustrating optics of the present invention.

FIG. 7 is an enlarged side elevational view of the R/W objective lens focusing a light beam in an optical path orthogonal to the surface of the disk.

FIG. 8 is an enlarged side elevational view of the R/W objective lens being

slightly tilted relative to the disk.

FIG. 9 is a diagram illustrating optics of the present invention.

FIG. 10 is a diagrammatic perspective view of a control system to provide a feedback on the orientation of a mirror of the present invention.

FIG. 11 is a diagrammatic perspective view of a head member with respect to the optical disk, illustrating the effects of the light beam focused onto the disk surface as the angle of the head mirror is changed.

FIG. 12 is a side elevational view of a foldable mirror according to the present invention.

FIG. 13 is a top plan view of the foldable mirror of FIG. 12.

DETAILED DESCRIPTION

Optical storage devices are used to optically read and write information from and onto a number of optical disks. The present invention uses at least one movable mirror, preferably two movable mirrors, to selectively guide a light beam from one or more light sources to one of the optical disks.

Referring to FIG. 1, an optical switching apparatus for optical disk drives according to the present invention is shown. The optical disk drive generally designated 10 includes one or more light sources such as a laser module 12 having a laser source and other components required to produce a laser beam 14. It should be noted that the optical switching apparatus of the present invention can be used with any number of laser modules 12. The need for using more than one laser sources, each laser source having different optical properties, may arise. For example, one laser source may be specifically configured for writing operations while another laser source is configured for reading operations.

The optical disk drive 10 includes a number of read/write (R/W) head members 16, each of which is associated with a surface of at least one of the optical disks 18. The optical disks 18 are arranged spaced axially from each other and supported on a spindle 20 rotatable by means of a drive motor 22. The optical disks 18 may have either one or two recordable sides. Information or data are stored in tracks formed on the reflective surfaces of the optical disks. The read/write head members are capable of moving

radially across the disk to selected track areas of the optical disks, e.g., linearly or arcuately with respect to the disk.

The illustrated optical switch apparatus includes first and second movable mirrors 24, 26 for selectively coupling a laser beam from one of the laser modules 12 to a selected head member 16. The optical path begins at one of the laser modules. The light beam 14 emitted by one of the laser modules impinges upon the first movable mirror 24. The angle of the first movable mirror 24 may be changed in order to switch between the laser modules. The first movable mirror 24 guides the light beam from the light sources to a specific location on the second movable mirror 26. This specific location may vary as described below. Once the beam reaches the second movable mirror 26, the beam is directed to one of stationary mirrors 28. The positions of the first and second movable mirrors 24, 26 are precisely adjusted to enable the light beam to be switched from one optical disk to another optical disk.

The movable mirrors 24, 26 have a reflective surface which is adjustable about at least one pivot axis and preferably about two pivot axes. The orientation of the reflective surface is controlled by a control mechanism. The control mechanism precisely controls the degree of rotation of the reflective surface in one or both pivot axes. The movements of the first and second movable mirrors are coordinated by a processor to selectively switch the direction of the laser beam between different optical disks. The movable mirror can be of any suitable type capable of enabling the light beam to be rapidly and accurately guided to a precise position as required by the optical disk drive. For example, the movable mirror may be an optical switching mirror apparatus as disclosed in U.S. provisional patent application Ser. No. 60/088,239 filed June 5, 1999 which is incorporated herein by reference.

Also included in the illustrated optical switching apparatus is a number of stationary mirrors 28. Each stationary mirror is associated with one of the R/W head members 16. The stationary mirrors 28 have reflective surfaces, each oriented at a predetermined pivotal angle, to deflect the light beam from the second movable mirror 26 to the respective head members 16. In use, the second movable mirror 26 aims the light beam to one of the stationary mirrors 28. The stationary mirror then reflects the beam arriving onto it to a respective R/W head member 16. The locations of the

stationary mirrors 18 are selected in such a way as to keep the optical path length from the laser sources 12 to the R/W heads 16 as constant as possible.

Referring to FIG. 2, the read/write heads 16 include at least one head mirror 30 to receive the light beam 34 from one of the stationary mirrors. An R/W objective lens 32 is located between the head mirror 30 and a respective disk surface 36 to focus the beam reflected by the head mirror onto a selected track of the optical media 18. The beam is preferably aimed into the center of the R/W objective lens 32, and the angle of the beam at which the beam passes through the R/W objective lens will determine focusing and tracking operations, as described below. The beam reflected from the surface of the optical disk 18 is monitored by a signal detector to reconstruct information stored on recording surfaces of disks.

Each read/write head 16 may include one or two sets of a head mirror and an R/W objective lens. One set will enable read/write operations on one surface, and two sets will enable reading/writing operations on two surfaces, for example, one surface above the R/W head and another surface below the R/W head. As seen by referring to FIGS. 1 and 2, the read/write heads 16 located between two adjacent optical disks 18 have two sets of a head mirror and an R/W objective lens. Such read/write heads are capable of read/write data of two facing sides of adjacent disks, for example, the bottom side of the upper disk and the top side of the lower disk. The incoming beam from one of the stationary mirrors 28 is directed onto one of the head mirrors 16 for purposes of performing read/write operations on one of the optical platters 18. It should be noted that use of one stationary mirror 28 to aim the beam to two R/W objective lenses 32 in the same R/W head member 16 may require increasing the size of the second active mirror 26 by more than twofold. In order to avoid this situation, it may be desirable to provide a separate stationary mirror assigned to each of the R/W objective lenses.

The focal plane 38 of common lenses is not planar but spherical, as shown in FIG. 3. The spherical focal plane 38 of the R/W objective lens 40 can be used for focusing the beam onto the optical platter 18. In FIG. 4, a view of the platter surface from the vantage point of the lens is shown. The circles 42 describe the best focus contours for different locations of the optical disk surface relative to the lens. The shallow arcs 44 are the different R/W tracks on the optical platter. The highlighted area is useful to reach

several tracks in a range of focus conditions. It is possible to reach different points in this area by making the light beam arrive at the lens from different directions.

FIG. 5 is shown to better illustrate the directing of the beam into the R/W objective lens 32. Here the second movable mirror 26 is shown as the stationary mirror 28 images it and designated 42. The R/W objective lens 32 is shown as imaged by the head mirror 30 and designated 44. Only one optical platter 18 is shown, with its image designated 46. Numeral 41 designates a plane of the stationary mirror 28, numeral 43 designates a normal to the stationary mirror 28 and numeral 45 designates a plane of the head mirror 30. As seen in FIG. 5, by directing the beam onto different locations on the second movable mirror 26, the beam may arrive into the R/W objective lens 32 from different directions, via different spots on the stationary mirror 28. The positioning of the beam on the second active mirror 26 in one dimension will control mainly tracking, while the other dimension will control mainly focus. (Some interaction between the two degrees of freedom exists, as seen in FIG. 4.)

The second movable mirror 26 is preferably sufficiently sized so that all required spots on it are available. For purposes of compensating for possible misalignments in the stationary mirrors 28, a slightly larger size of the second movable mirror may be desirable. In order to avoid creating a need for excessively large second movable mirror, the R/W head members 16 are preferably configured such that they move linearly with respect to the stationary mirrors. If the R/W head members 16 move along an arc or radially with respect to the disk 18, a larger sized second movable mirror 26 and larger sized stationary mirrors 28 are required. The distance from the second movable mirror to the R/W objective lenses is preferably minimized in order to minimize the size of the second movable mirror.

Referring to FIG. 6, a drawing of the R/W objective lens is made with only the axis of the possible beams shown. The focal length of the lens is represented by u, the diameter of the beam is represented by x, the size of the second movable mirror is represented by X, and the distance between the second movable mirror and the R/W objective lens is represented by L. As an example, let us assume that the focal length (u) of the lens is 1 mm. The separation between the tracks is 1 micron, and 10 tracks should be addressable. In this case, the different arriving angles for track control should be:

$$A = x / u = 10*10^{-6} / 1 * 10^{-3} = 10 * 10^{-3} \text{ Radians}$$

(The platter - lens distance which must be different from the focal length was approximated as equal to the focal length for this calculation only. This introduces error of less than 1% in the final result. Also, small angles and thin lenses are approximated.)

If the optical path distance (L) between the second movable mirror and the R/W objective lens is 100 mm (0.1 m), the required beam wander on it will be:

$$X = L * A = 0.1 * 10 * 10^{-3} = 1 * 10^{-3} \text{ m} = 1 \text{ mm}$$

Adding this dimension to a beam diameter of 1 mm, the mirror size should be 2 mm.

Referring to Fig. 7, the R/W objective lens 32 focusing a light beam 48 in an optical path orthogonal to the surface 52 of an optical disk 54 is shown. The focal radius of the R/W objective lens is represented by R. By way of an example, a lens with 1 mm focal length will have 0.5 mm radius of the focal plane spherical surface. If the beam wander on the second movable mirror is also 1 mm in the dimension controlling the focus, the possible focus adjustment is:

$$h = x^2 / (2*R) = (10*10^{-6})^2 / (2*0.5*10^{-3}) = 1*10^{-7} \text{ m} = 0.1 \text{ micron}$$

Increasing the mirror size to 3 mm in the dimension controlling focus will increase the possible beam wander on the mirror in this dimension to 2 mm, with focus adjustment increased four times to 0.4 up.

Referring to FIG. 8, the R/W objective lens 32 being slightly tilted relative to the optical disk 54 is shown. Numeral 76 designates the axis of the laser beam, numeral 78 designates the axis of the lens and numeral 80 designates the focal plane of the R/W objective lens. Tilting the lens 32 relative to the platter 54 can increase the amount of possible focus adjustment. Tilt of 0.1 Radians will allow approximately 1 micron focus adjustment with 2 mm mirror, and 2 microns adjustment with 3 mm mirror.

The operation of the present invention will now be described. Referring back to FIG. 1, one of the optical platters 18 is first selected. The head member 16 associated with the selected optical platter is moved to a target track area of the selected optical platter. The head member may move either linearly or radially with respect to the optical platter. One of the laser modules 12 emits a light beam 14 in the direction of the first movable mirror 24. The first movable mirror 24 receives the laser beam from the laser source and aims the beam onto a specific point on the second movable mirror 26 by

changing the orientation of its reflective surface. The location of the specific point on the second movable mirror is determined according to the tracking and focusing needs. The second movable mirror is positioned to precisely guide the light beam to one of the selected stationary mirrors, such that the beam from the stationary mirror is deflected by a head mirror and guided to the center of an R/W objective lens associated with the selected optical disk.

When the requested data is stored on a different optical disk, the processor controls the movements of the first and second movable mirrors to switch the beam from one optical disk to another optical disk. The alignment of the first and second movable mirrors 24, 26 will depend on the exact positioning of the selected R/W head member 16 with respect to the respective stationary mirror 28. The tracking of the optical disk 18 is only possible relative to the exact position of the R/W head member 16. In order to obtain calibration parameters, a calibration of all optical parameters will be conducted by searching for the best alignment of the mirrors for each track on the optical platters. During normal operation, the calibration parameters will be used for fast positioning of the movable mirrors 24, 26 in order to rapidly and accurately switch the beam from one optical disk 18 to another. In addition, slow adjustments of the calibration parameters will be made as mechanical parameters drift due to time, temperature, etc.

The imaging design of the optical system is preferred. Due to the optical distance between the laser lens and the R/W objective lens, collimating the beam will create a large loss of light. Referring to FIG. 9, numeral 57 designates a laser, numeral 56 designates a laser lens, numeral 58 designates an R/W objective lens, and numeral 59 designates an optical disk. The laser beam emitted from the laser 57 travels from the left to the right in FIG. 9. The laser emitting area, with diameter d_1, is preferably imaged onto the aperture of the R/W objective lens 58:

$$1/f_1 = 1/u_1 + 1/v \quad \text{and} \quad D_2 = m_1 * d_1 \quad \text{where} \quad m_1 = v/u_1$$

The read/write spot is preferably imaged onto the laser lens 56:

$$1/f_2 = 1/u_2 + 1/v \quad \text{and} \quad D_1 = m_2 * d_2 \quad \text{where} \quad m_2 = v/u_2$$

In addition, the Numerical Aperture ("NA") of the laser preferably matches the lens as follows:

$$NA_{laser} = \text{Sin}((D_1/2) / u_1)$$

Similarly:

$$NA_{spot} = \text{Sin}\ ((D_2 /2) / u_2)$$

Loss of light will result if any of the above equations is not satisfied. All the mirrors and beam splitters in the optical path are planar and will not influence the imaging design. Similar design applies to the detector and its lens.

The optical switching apparatus includes a feedback mechanism for monitoring the resulting movements of the movable mirrors. Referring to FIG. 10, a control system for providing a feedback on the orientation of a movable mirror is shown. The read/write laser beam is represented by numeral 65. A feedback on the position of a movable mirror 66 may be provided using an auxiliary light beam 62 emitted by an auxiliary light source 60 and a position sensitive or quadrant detector 64. For example, to control the first movable mirror, one detector chip sized similar to the second movable mirror may be sufficient to monitor the movements of the first movable mirror during the operation thereof. However, to control the second movable mirror, a large position detector chip may be needed, sized as all the stationary mirrors array. Alternatively, several small detectors, each associated with one or two stationary mirrors, may be used to establish position feedback for the second movable mirror. The auxiliary beam may be modulated to improve signal to noise ratio.

The head mirrors of the R/W head members may be fixed or non-movable mirrors, once aligned and forgotten. The head mirrors may require a precise alignment since the exact positioning of these mirrors determines the direction from which the beam arrives at the R/W objective lens, as shown in FIG. 11. For purposes of controlling the angle of the beam at which the beam passes through the R/W objective lens, the head mirror may be a movable or foldable mirror with one or two degrees of freedom. Upon first operation, an alignment of the movable head mirrors may be controlled by a processor. The movable head mirrors may be constructed using known Micro Electro Machined ("MEM") technology.

FIGS. 12 and 13 show the movable head mirror 68 according to the present invention. The movable head mirror 68 includes a reflector 70 supported between a support base 82 and two linear actuators 74. The reflector 70 is pivotally connected at one end to the support base 82 via a first hinge 72. At the other end of the reflector, bars

84 are pivotally connected between the reflector 70 and the linear actuators 74 via a second set of hinges 86 and a third set of hinges 88, respectively. The linear actuators 74 control the orientation of the reflector 70 with two degrees of freedom required for focus and tracking control. The movable head mirror 68 may be aligned once and forgotten, or it may be adjusted continuously for focusing and tracking purposes. Alternatively, the movable head mirror 68 may be used for slow adjustments; for example, to correct focus drift with temperature changes.

While the foregoing preferred embodiments of the invention have been described and shown, it is understood that variations and modifications, such as those suggested and others within the spirit and scope of the invention, may occur to those skilled in the art to which the invention pertains. The scope of the present invention accordingly is to be defined as set forth in the appended claims.

CLAIMS

What is claimed is:

1. An optical disk drive for optically reading and/or writing information from and onto a plurality of optical disks rotatably supported about an axis using a light beam generated by a light source, comprising:

plurality of head members, each head member being associated with at least one of the optical disks; and

a beam-directing apparatus for selectively coupling the light beam from the light source to a selected head member, wherein said beam-directing apparatus includes at least one movable mirror having a reflective surface which changes its orientation to direct the light beam toward the selected head member.

2. The optical disk drive as claimed in claim 1, wherein said beam-directing apparatus comprises a first movable mirror, a second movable mirror, wherein said first and second movable mirrors are arranged to selectively couple the light beam from the light source to one of said head members.

3. The optical disk drive as claimed in claim 1, further comprising a plurality of stationary mirrors, each stationary mirror associated with one of said head members and includes a reflective surface oriented at a predetermined pivotal angle to deflect the light beam from the second movable mirror to the respective head member.

4. The optical disk drive as claimed in claim 3, wherein each respective head member comprises a head mirror, an R/W objective lens located between the head mirror and the respective disk for focusing the light beam from the head mirror onto the respective disk, and wherein said head mirror is positioned to guide the light beam from the stationary mirror to said lens.

5. The optical disk drive as claimed in claim 4, wherein said first movable mirror is adjustable to guide the light beam from the light source to a specific point on said second movable mirror, and said second movable mirror is adjustable to guide the

light beam from the first movable mirror to one of said stationary mirrors.

6. The optical disk drive as claimed in claim 4, wherein said stationary mirrors are positioned such that the optical path length from the light source to each of the head mirrors are substantially the same.

7. The optical disk drive as claimed in claim 1, wherein at least one of the head members is associated with a reflective surface of one of the disks and a reflective surface of another disk adjacent thereto.

8. The optical disk drive as claimed in claim 1, wherein each of said first and second movable mirrors is adjustable about a first pivot axis and a second pivot axis and includes a control mechanism to control the degree of rotation thereof in both axes.

9. The optical disk drive as claimed in claim 8, further comprising a processor operatively coupled to the first and second movable mirrors for controlling pivotal angles of the first and second movable mirrors.

10. The optical disk drive as claimed in claim 1, wherein the first movable mirror is adjustable to guide the light beam from the light source onto a specific point on the second movable mirror according to tracking needs and focusing needs.

11. The optical disk drive as claimed in claim 10, wherein positioning the light beam on the second movable mirror along one axis generally controls tracking while positioning the light beam on the second movable mirror along another axis perpendicular to said one axis generally controls focus.

12. The optical disk drive as claimed in claim 4, wherein at least one of the head mirrors is an active folding mirror to provide adjustment required for focusing and tracking control.

13. The optical disk drive as claimed in claim 12, wherein said active folding mirror comprises a reflector movable about a pivot axis and an actuator for controlling the angle of the reflector, wherein said reflector is adjustably supported between a support base and said actuator so as to cause said reflector to rotate about said pivot axis in one direction as the actuator moves toward the reflector and cause said reflector to rotate about said pivot axis in the other direction as the actuator moves away from the reflector.

14. A beam-directing apparatus for directing a light beam from at least one light source to one of a plurality of optical disks, comprising:

a first mirror for reflecting the light beam from said at least one light source;

a second mirror for reflecting the light beam reflected from said first mirror; and

wherein at least one of said mirrors is adjustable to selectively guide the light beam from the light source to one of said disks.

15. The beam-directing apparatus as claimed in claim 14, wherein at least one of said first and second mirrors is adjustable about a pivot axis and includes a control mechanism to control the degree of rotation thereof about said pivot axis.

16. The beam-directing apparatus as claimed in claim 14, wherein at least one of said first and second mirrors is adjustable about a first pivot axis and a second pivot axis and includes a control mechanism to control the degree of rotation thereof in both axes.

17. The beam-directing apparatus as claimed in claim 14, further comprising a plurality of light sources, and wherein said first mirror is adjustable to guide the light beam emitted from one of said plurality of light sources to a specific point on said second mirror.

18. An optical switching apparatus for switching of a light beam from at least one light source to one of a plurality of outputs, comprising:

a first movable mirror for reflecting the light beam from said at least one light source;

a second movable mirror for reflecting the light beam reflected from said first movable mirror; and

wherein said first movable mirror is adjustable to guide the light beam from said at least one light source to a specific point on said second movable mirror, and said second movable mirror is adjustable to guide the light beam from the first movable mirror to one of said outputs.

19. The optical switching apparatus as claimed in claim 18, wherein each of said movable mirrors is adjustable about a pivot axis and includes a control mechanism to control the degree of rotation thereof about said pivot axis.

20. The optical switching apparatus as claimed in claim 18, wherein each of said movable mirrors is adjustable about a first pivot axis and a second pivot axis and includes a control mechanism to control the degree of rotation thereof in both axes.

21. The optical switching apparatus as claimed in claim 18, further comprising a plurality of light sources, and wherein said first movable mirror is adjustable to guide the light beam emitted from one of said plurality of light sources to a specific point on said second movable mirror.

22. An adjustable mirror assembly, comprising;

a mirror unit including a reflective surface;

a first stationary flexible pivot;

a second movable flexible pivot;

a third movable flexible pivot; and

means for moving said second and third flexible pivots, wherein movement of said second and third pivots provides for two degrees of angular control with respect to said reflective surface of said mirror unit.

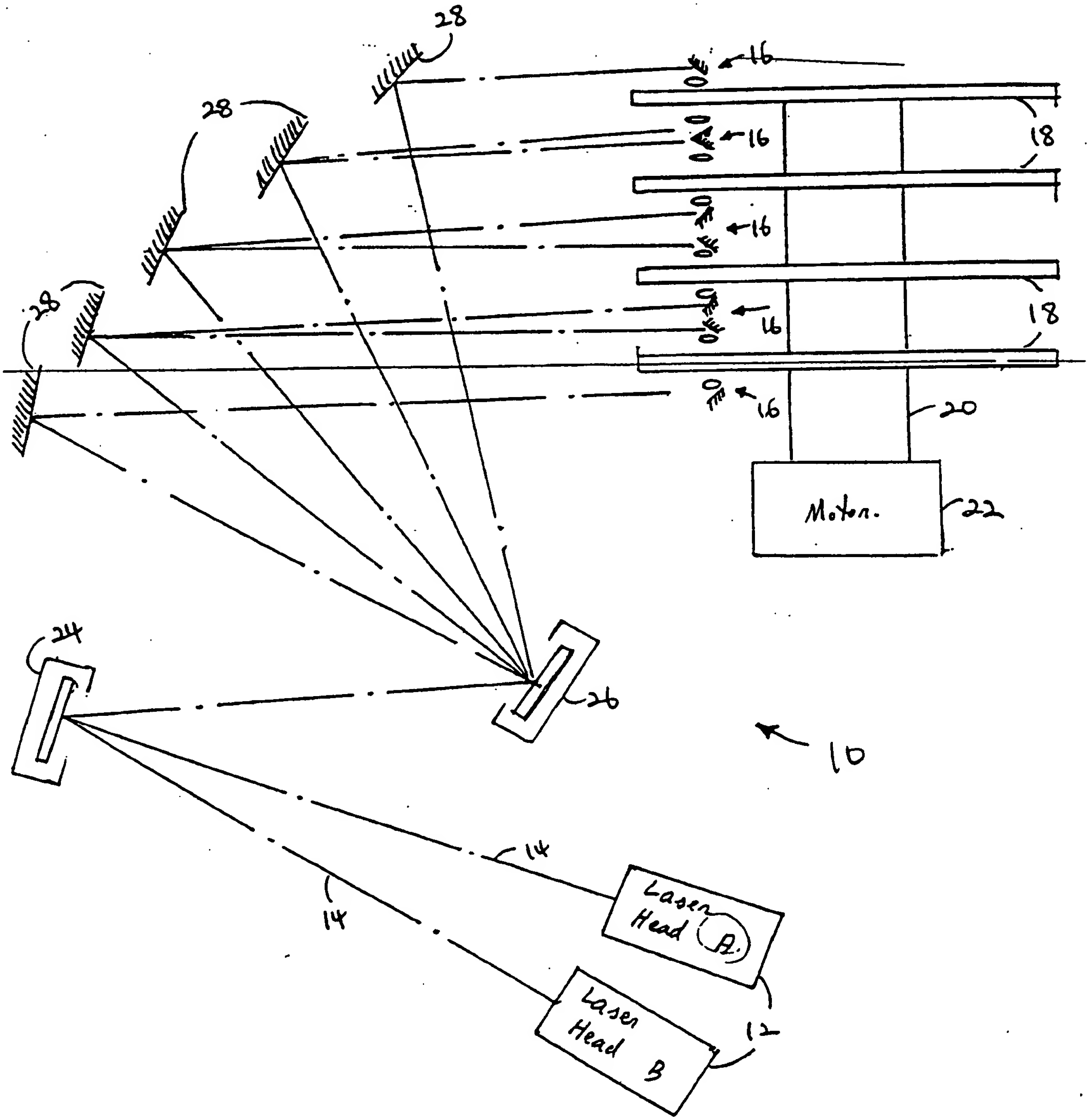
23. An adjustable mirror assembly as set forth in Claim 22, wherein said means for moving is operatively associated with an optical disk drive controller so as to direct an optical beam to a desired disk location.

24. An adjustable mirror assembly as set forth in Claim 23, wherein said means for moving and optical disk drive controller cooperate to manipulate said reflective surface so as to control tracking and focusing of said optical beam with respect to a disk.

25. A method for selectively coupling a light beam from at least one light source to a plurality of outputs using a first movable mirror having a first reflective surface pivotable about at least one pivot axis and a second movable mirror having a second reflective surface pivotable about at least one pivot axis, said method comprising the steps of:

controlling a pivotal angle of the first reflective surface of the first movable mirror to reflect the light beam from said at least one light source to a selected optical path; and

controlling a pivotal angle of the second reflective surface of the second movable mirror to reflect the light beam reflected from the first movable mirror to a selected one of said plurality of outputs.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Motor.
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Laser Head A.
Laser Head B
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Fig 1

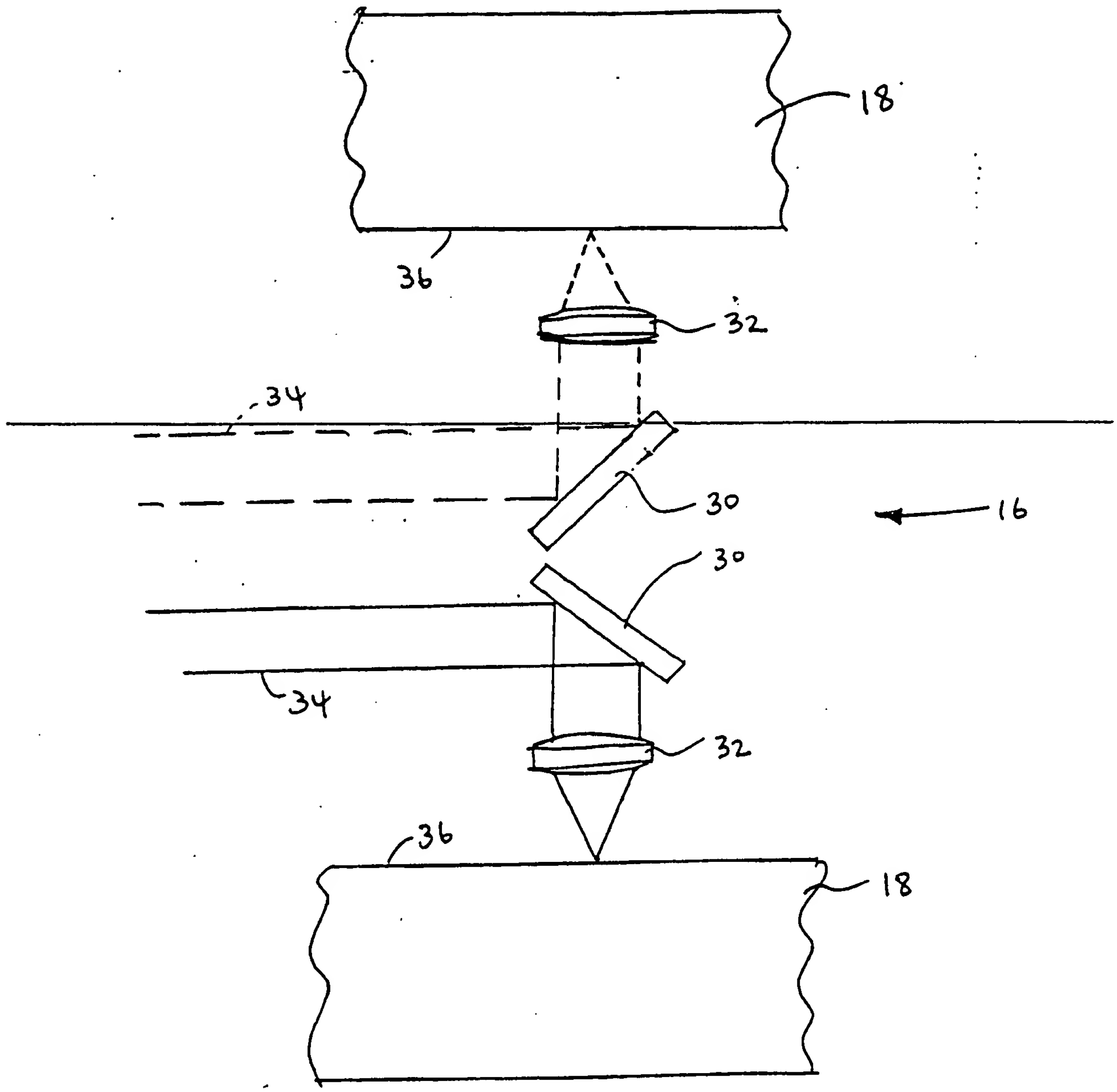

Fig 2

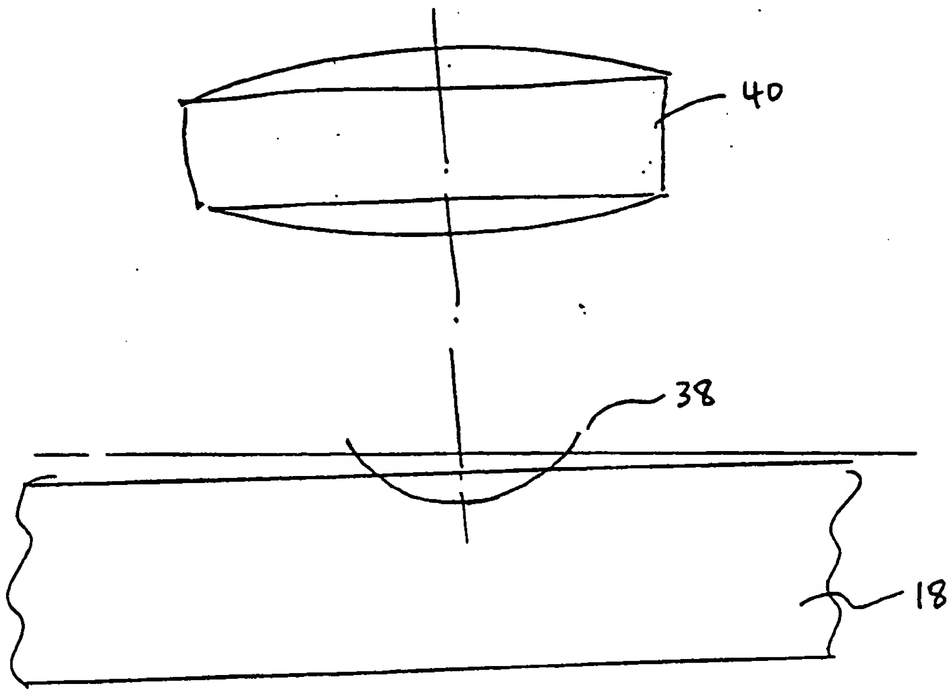

Fig 3

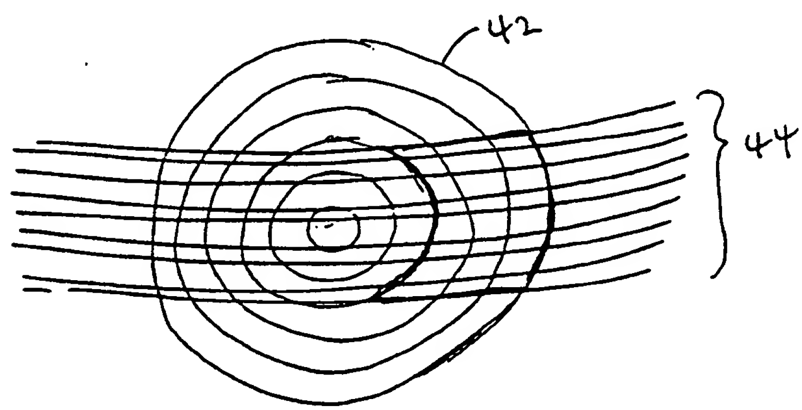

Fig 4

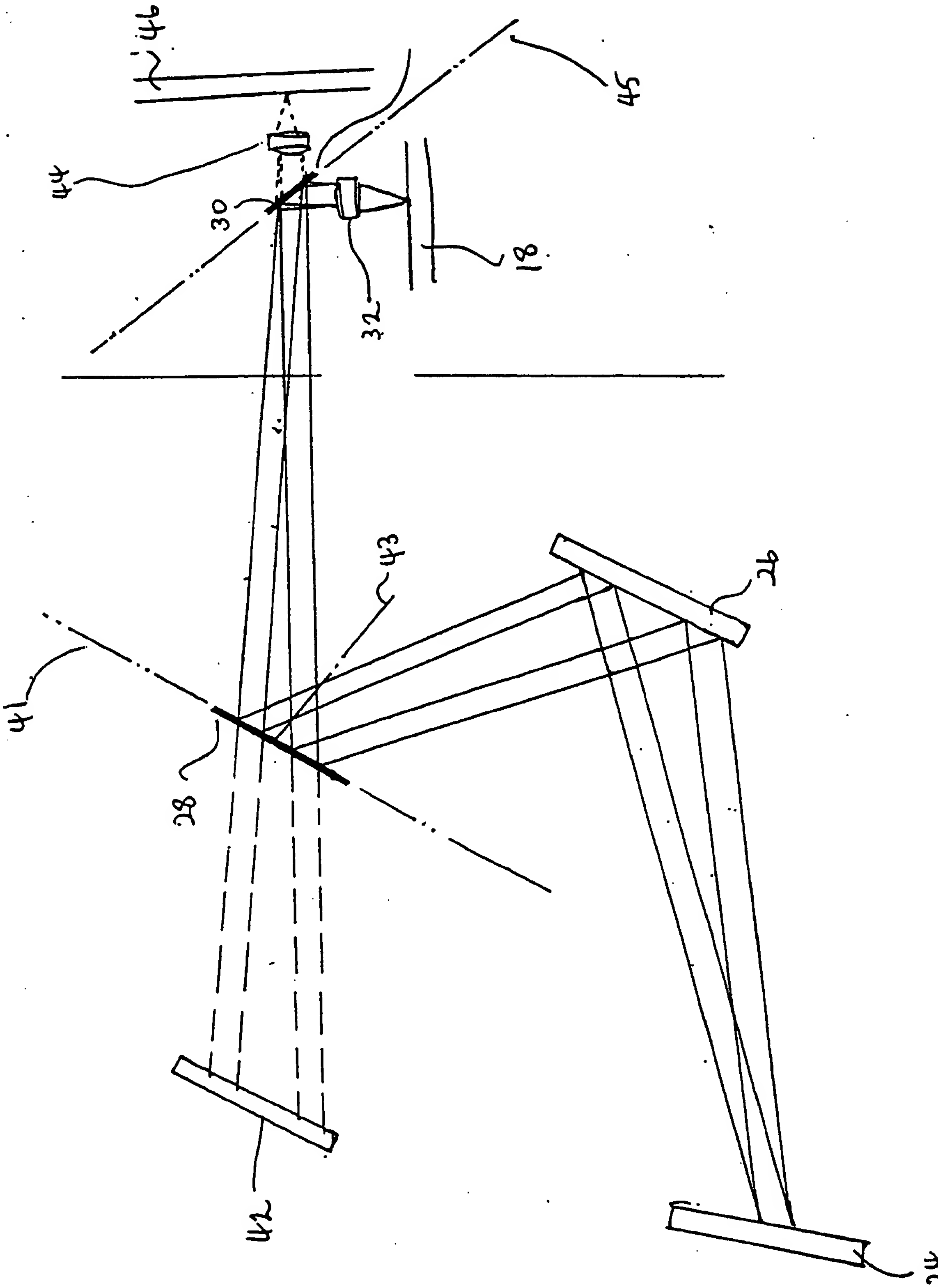

Fig 5

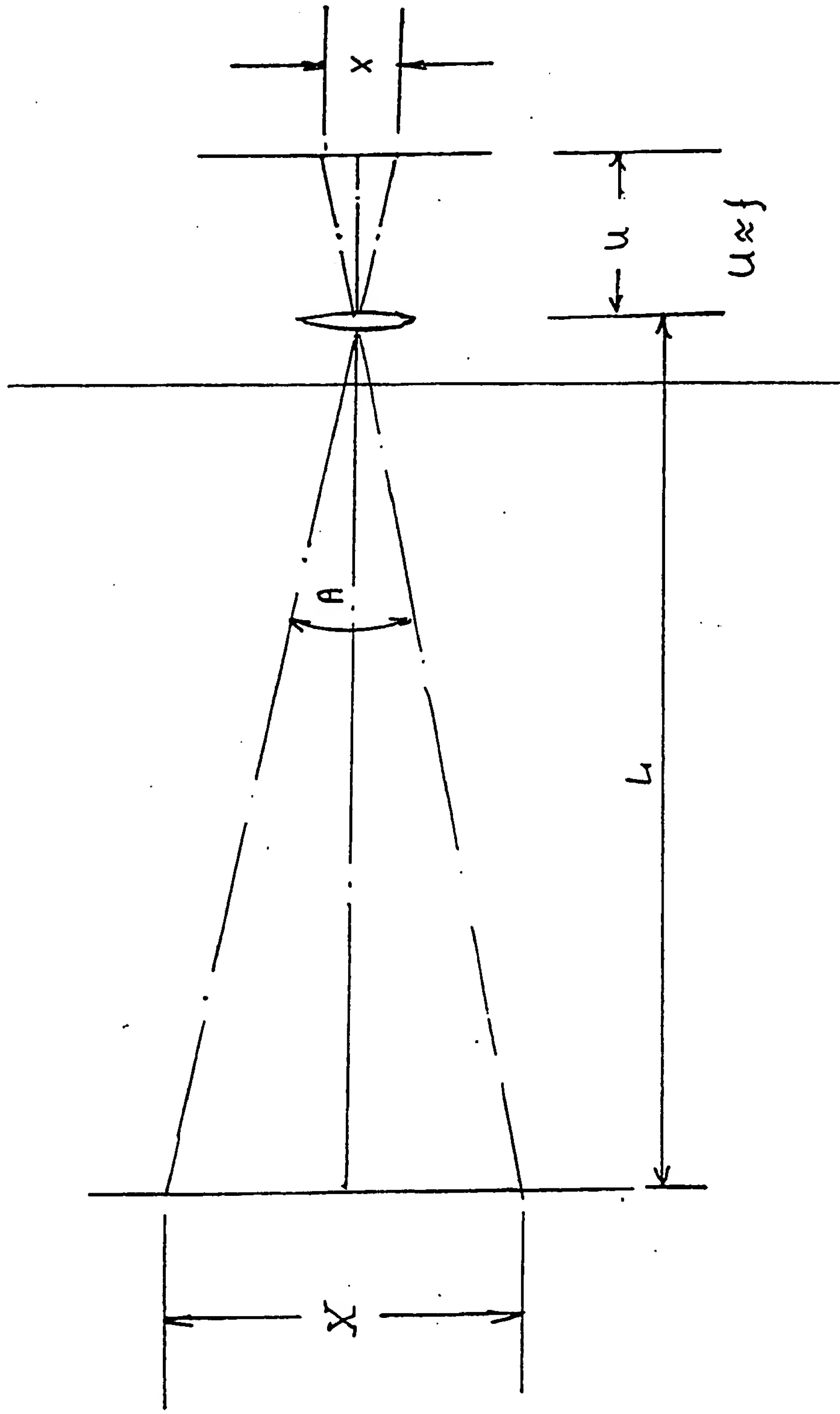

Fig 6

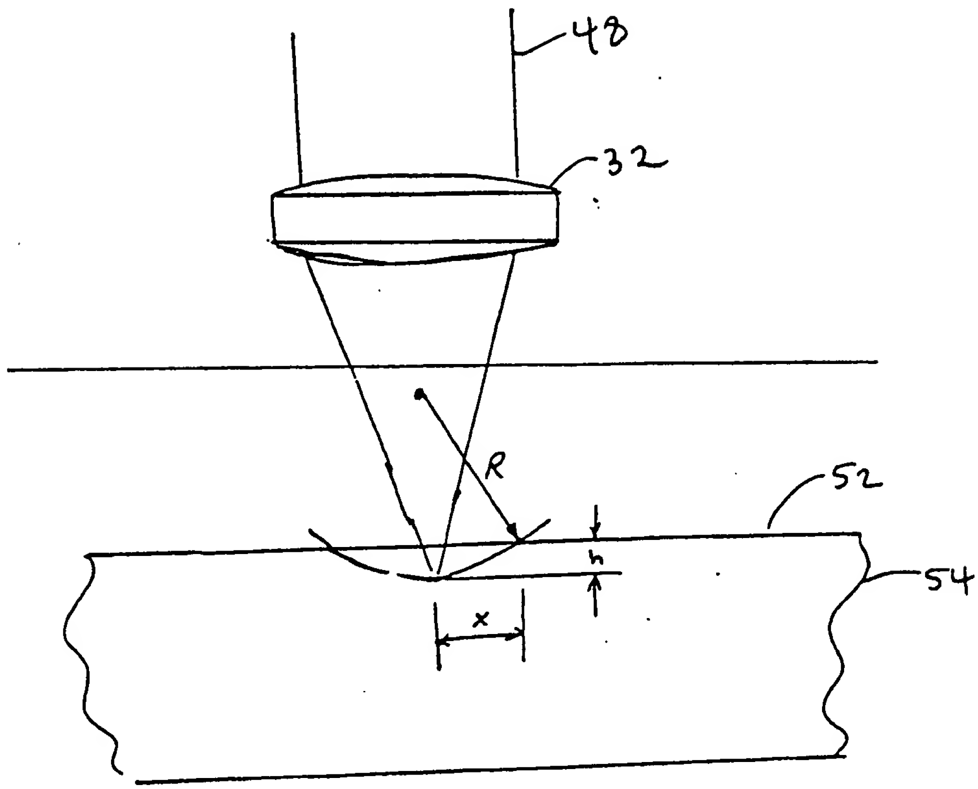

Fig 7

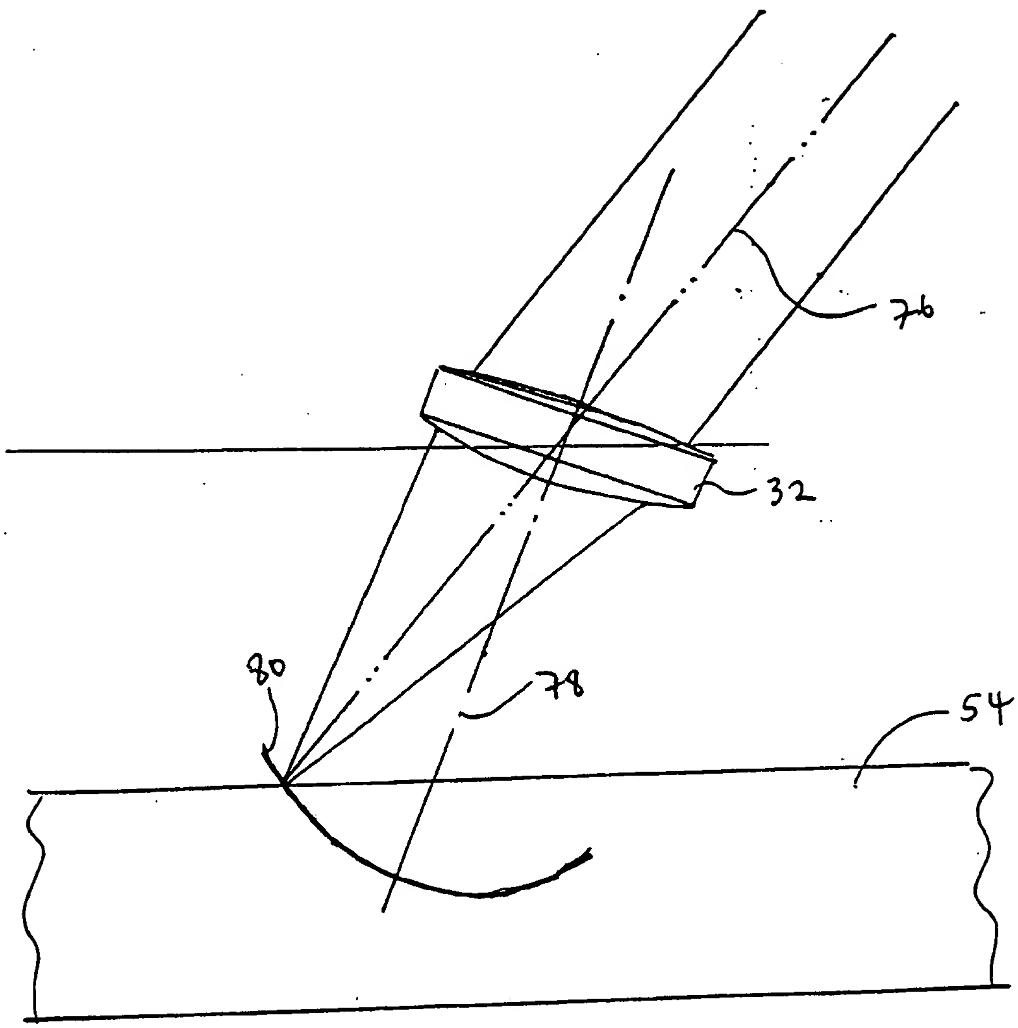

Fig 8

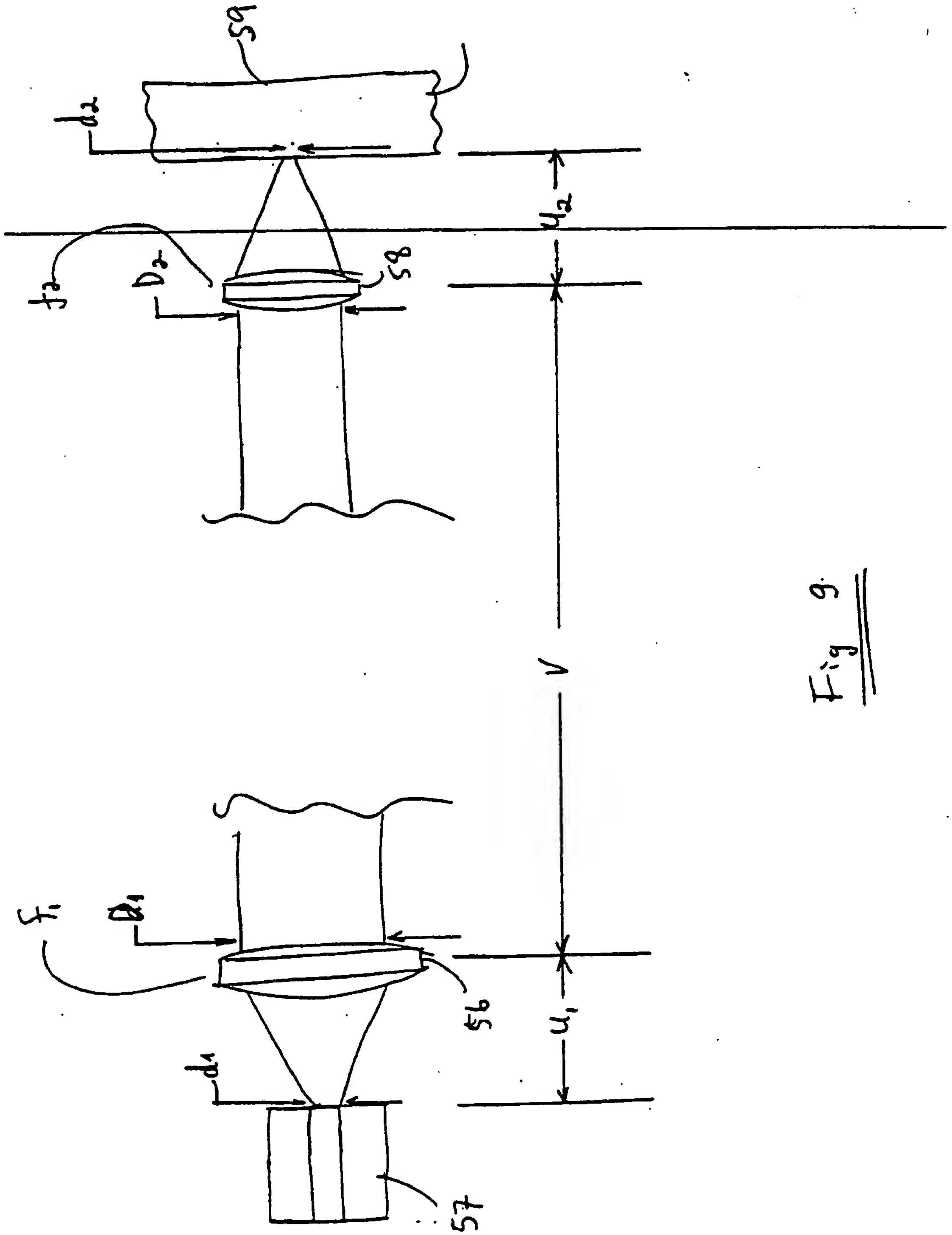

Fig 9

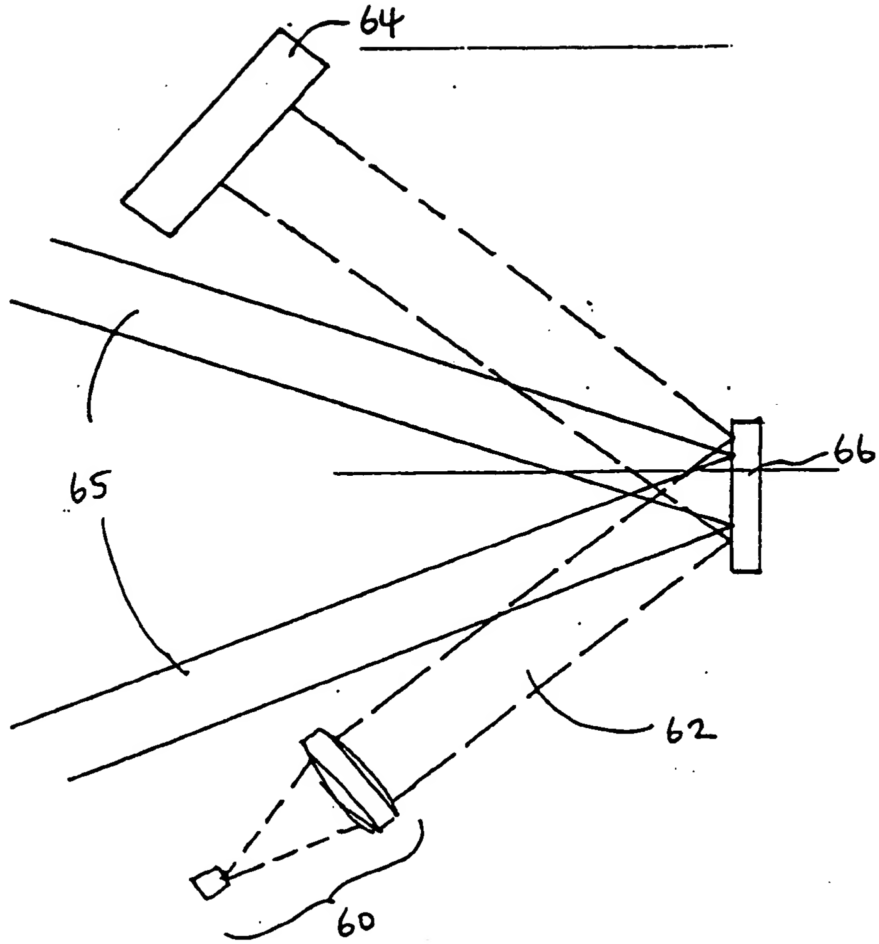

Fig 10

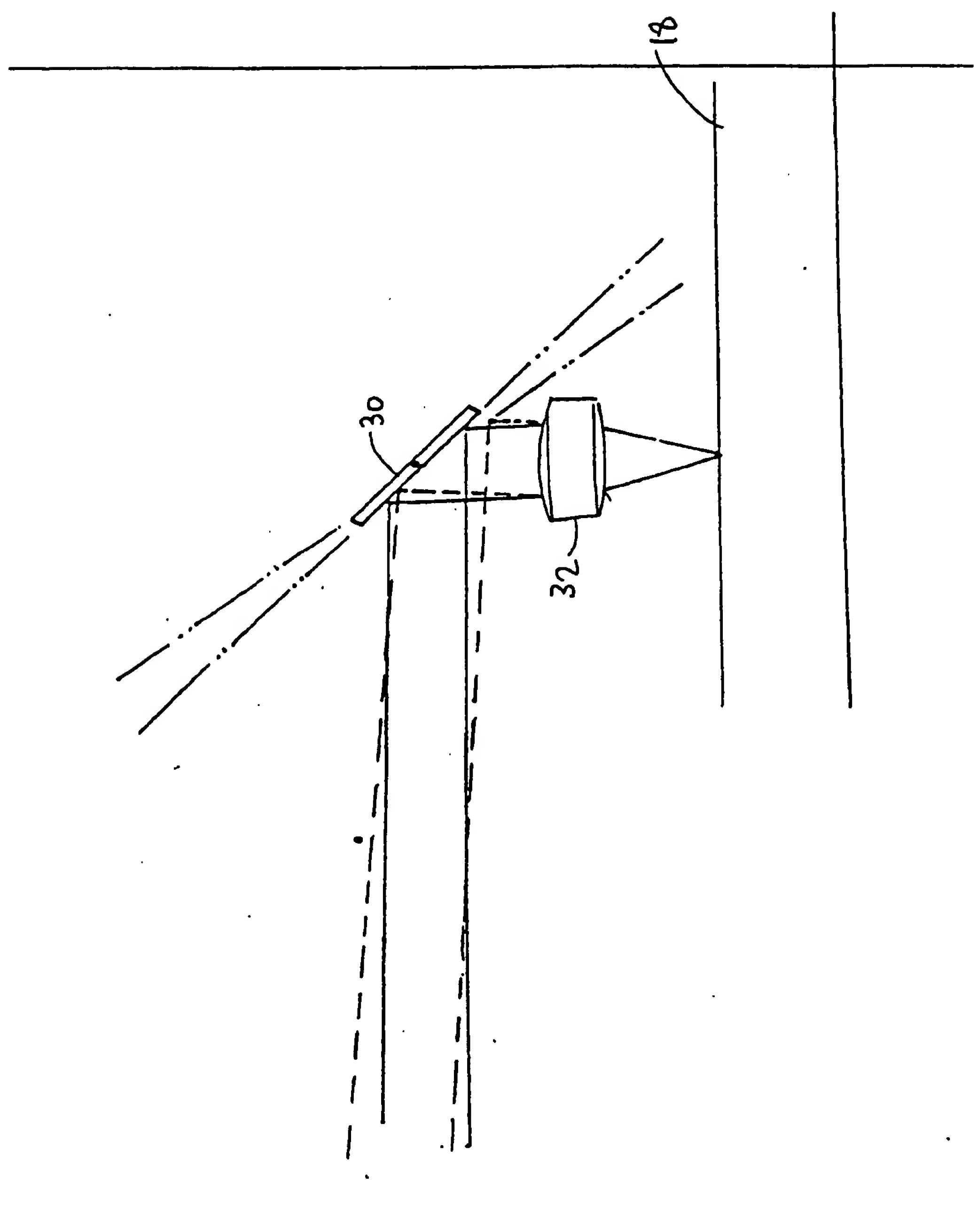

Fig 11

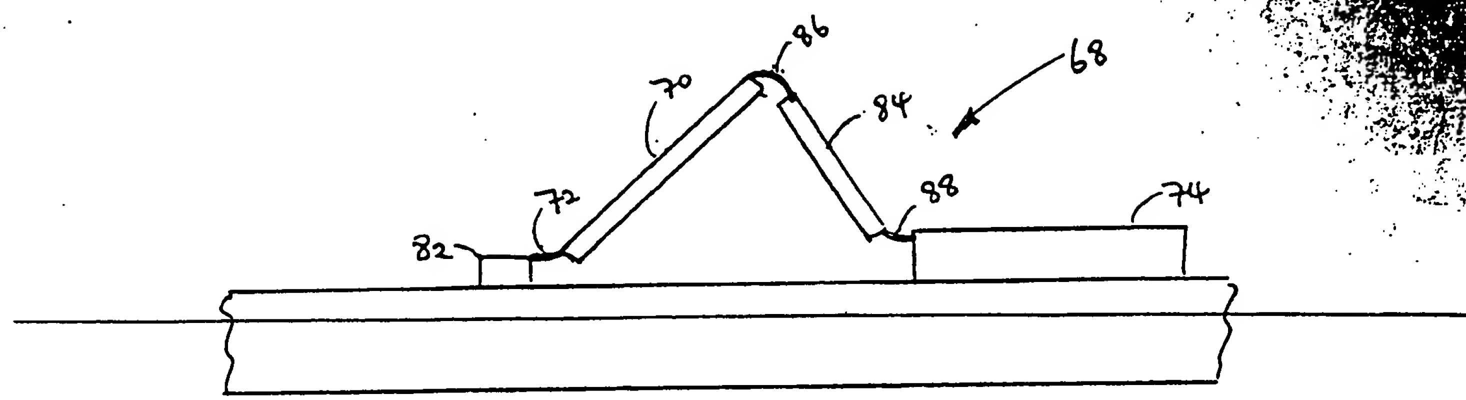

Fig 12

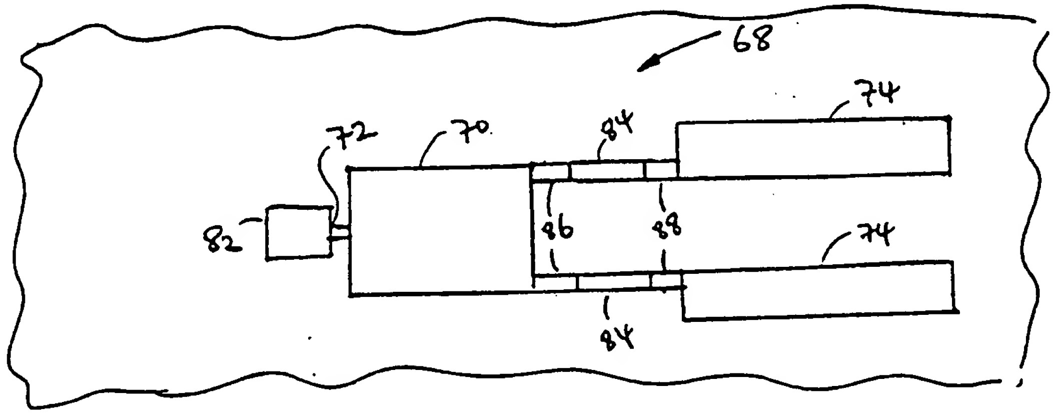

Fig 13